Dispersion Forces Between Interfaces in Type-I Superconductors

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It was recently found, within Ginzburg-Landau theory, that type-I superconductors with surface enhancement of superconductivity show interface delocalization, or 'wetting', phase transitions of both first and second order [1]. The effective interface potential V(l) for a surface superconducting sheath of thickness l decays exponentially on the scale of the correlation length [2]. This signifies, in the usual terminology of wetting transitions, interactions of short-range. One may wonder whether, as, e.g., in fluids, algebraically decaying contributions to V(l) also arise in the type-I superconductors, as the dielectric polarizabilities of superconducting and normal phases are not identical [3]. In order to determine a contribution arising from this difference, the dielectric functions of metals and superconductors have to be inspected, which, on the basis of BCS-theory of superconductivity, were calculated long ago [4]. It is found that planar interfaces of a type-I superconductor with vacuum, normal conductors, or other superconductors interact via long-ranged (algebraic) dispersion forces. For the effective interface potential of a type-I superconductor with surface enhancement, dispersion forces give rise to an algebraic correction of the unusual form V(l) ~ 1/(l**5), where l is the thickness of the surface superconducting sheath. The dispersion force contribution can be either attractive or repulsive, depending on the superconductor used for surface enhancement. For strongly type-I superconductors such as Al, the long-range dispersion forces usually are a small correction. For type-I superconductors that show a critical wetting transition in GL-theory for which $\kappa > 0.374$, long-range forces may lead to a quantitative change of the divergence of the wetting layer, from logarithmic to power-law. Also, depending on the superconductor used for surface enhancement, the forces may become agonistic, turning the critical transition first-order.

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